We claim:

1. A device comprising:

a matter system having a first energy level and a second energy level such that a signal photon couples to a transition between the first energy level and the second energy level;

a first source providing a first beam that contains photons that couple to a transition between the second energy level and a third energy level of the matter system, the first source directing the first beam to interact with the matter system;

a second source providing a second beam that contains photons that couple to a transition between the third energy level and a fourth energy level of the matter system, the second source directing the second beam to interact with the matter system; and

a measurement system arranged to measure a change in one of the first beam and the second beam to detect the signal photon in the matter system.

2. The device of claim 1, wherein the second beam has an energy that is about equal to that of the first beam.

3. The device of claim 1, wherein a ratio of an energy of the first beam and an energy of the second beam is between 0.1 and 10.

4. The device of claim 1, wherein the first beam has an energy that is less than 100 times that of a state containing a single photon.

5. The device of claim 1, wherein the first beam has an energy that is between 10 and 50 times that of a state containing a single photon.

6. The device of claim 1, wherein the first beam and the second beam have a continuous duration that extends beyond a pulse width of a signal photon state being measured.

7. The device of claim 1, wherein the second source comprises:

a laser; and

a first beam splitter positioned to split an output beam from the laser into a first spatial component that is directed into the measurement system and a second spatial component that forms the second beam.

8. The device of claim 7, wherein the measurement system comprises:

a second beam splitter positioned to recombine the first spatial component and the second spatial component after the second spatial component interacts with the matter system; and

a photodetector along a light path from the second beam splitter.

9. The device of claim 1, wherein the measurement system comprises a dual-homodyne measurement system.

10. The device of claim 1, wherein the second beam is initially in a coherent state, and when a signal photon is in the matter system, the second beam exits from the matter system in a state that is not a coherent state.

11. The device of claim 1, wherein the matter system causes a non-linear interaction between the signal photon state and the probe photon state.

12. The device of claim 11, where the non-linear interaction arises from electromagnetically induced transparency created in the matter system.

13. The device of claim 1, further comprising:

a photon source that generates a signal state that has chances of including 0 or 1 photon; and

a photon storage system that stores the photon of the signal state in response to the measurement system detecting that the signal state includes 1 photon.

14. The device of claim 1, wherein the matter system comprises a series of atoms positioned to interact with the signal photon and the first and second beams, wherein electron states in each atom correspond to the first, second, third, and fourth energy levels.

15. The device of claim 14, wherein the atoms are of an element selected from the group consisting of: erbium (Er), praseodymium (Pr), and other lanthanide series metals; rubidium (Rb), cesium (Cs) and other alkali metals; and alkaline earth metals.

16. The device of claim 1, wherein the device is a detector capable of detecting presence or absence of one signal photon in a signal state.

17. A method for detecting a number of photons in a signal state, comprising:

directing the signal state into a gate;

directing a probe state into the gate; wherein the probe state is a coherent photon state having an intensity parameter with a magnitude less than about 10, and the gate causes a non-linear interaction between the signal state and the probe state;

measuring a change in the probe state that arises from the non-linear interaction; and

inferring the number of photons in the signal state from the changes in the probe state.

18. The method of claim 17, wherein the gate comprises a matter system having multiple energy levels.

19. The method of claim 18, wherein each photon in the signal state provides a coupling between a first energy level and a second energy level of the matter system.

20. The method of claim 19, wherein each photon in the probe state provides a coupling between a third energy level and a fourth energy level of the matter system.

21. The method of claim 20, further comprising applying a control field containing photons that provide a coupling between the second energy level and the third energy level of the matter system.

22. The method of claim 21, where in the control field comprises a coherent photon state having a photon number expectation value about equal to that of the probe state.